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Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°**

02256348.0

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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If no title is shown please refer to the description.
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Means for suppression of pass-band ripple in bulk acoustic wave filters

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AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

DESCRIPTION

Means for suppression of pass-band ripple in bulk acoustic wave filters

Bulk acoustic wave filters are constructed of bulk acoustic wave resonators which can be connected in a ladder or lattice type configuration. Alternatively also acoustically coupled and stacked crystal resonator configurations can be used to shape the filter curve. To de-couple the resonator from the substrate either acoustic Bragg reflectors consisting of $\lambda/4$ multilayers can be used. Alternatively the resonator can be isolated from the substrate by using an air gap or by creating a membrane structure by etching away the substrate. However, in membrane type resonator structures spurious membrane modes can be excited which can be suppressed only by shaping the membrane in a special way (irregular shape) and by applying absorption layer consisting of a visco-elastic damping material around the resonator edges to suppress lateral propagating acoustic modes (see eg. US006150703A).

Bragg reflectors have the advantage of having less spurious modes since mainly the longitudinal extensional modes is excited in the piezoelectric film inside the resonator. However, the reflector has to have a high reflection coefficient near 100% in the pass-band of the BAW filter to avoid that acoustic energy penetrates into the substrate and causes vibrations of the substrate. To get a high reflection coefficient of the reflector, one needs several of pairs of layers of material having high and low acoustic impedance (typical 5). For some applications (IF filters), which do not require extremely low insertion loss, the number of pairs in the reflector could be reduced. This would save processing time and manufacturing cost. However, then more acoustic energy would pass towards the substrate and the vibrations of the substrate could be seen as a strong ripple in the pass-band of the BAW filter.

Aim of the invention is to provide means to reduce this pass-band ripple by absorbing or scattering the longitudinal acoustic wave traveling though the substrate. Below the means are listed which by which the pass-band ripple can be reduced:

The figures show different BAW resonators with absorbing layer to suppress passband ripple in a BAW resonator filter. 1= top electrode, 2= piezoelectric layer(e.g. AlN), 3 = bottom electrode, 4 = Bragg reflector, 5=absorbing layer, 6 = substrate, 7=roughened substrate.

1. Roughening rear side of substrate (Fig. 1).
2. Adding an absorbing layer (e.g. epoxy glue) to the rear side of the substrate (Fig. 2).
3. Adding an absorbing layer on front of substrate and below Bragg reflector (Fig. 3).
4. Combination of means 1-3.

In Fig.4 is shown an example of a BAW resonator filter curve in which the pass-band ripple is reduced by adding an absorbing layer on top of substrate (e.g.a glass substrate and epoxy glue as absorbing layer). The Bragg reflector is consisting of alternate $\lambda/4$ layers of SiO_2 and Ta_2O_5. On top of this reflector the bottom electrode Pt and the piezoelectric film is stacked. As top electrode is used Al. As can be seen, the pass-band is free of any ripple. This is due to the use of an absorbing layer underneath the Bragg reflector on top of the glass substrate. The absorbing layer used was epoxy glue. Other materials which can be used as acoustic absorber: viscoeleastic materials such as polyimide, all kind of glue, rubber, plastic materials, porous media, porous thin films etc. in which either acoustic absorption mechanisms are dominant or acoustic scattering occurs.

CLAIMS

1. Bulk acoustic wave filters comprising a substrate with a front side and rear side and a Bragg reflector wherein the rear side of the substrate is roughened.

2. Bulk acoustic wave filters according to claim 1, comprising also an absorbing layer between the front side of the substrate and the Bragg reflector.

3. Bulk acoustic wave filters according to claim 1, comprising also an absorbing layer at the rear front side of the substrate

ABSTRACT

Means for suppression of pass-band ripple in bulk acoustic wave filters

Bulk acoustic wave filters comprising a substrate with a front side and rear side and a Bragg reflector wherein the rear side of the substrate is roughened.

Fig. 1

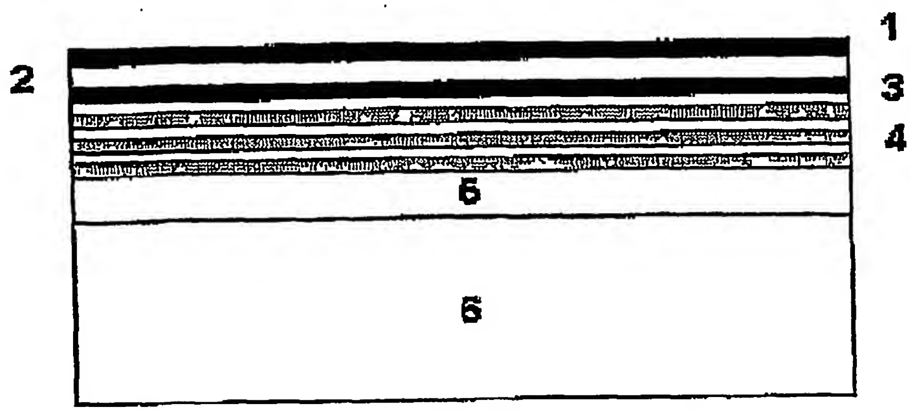

Fig. 1

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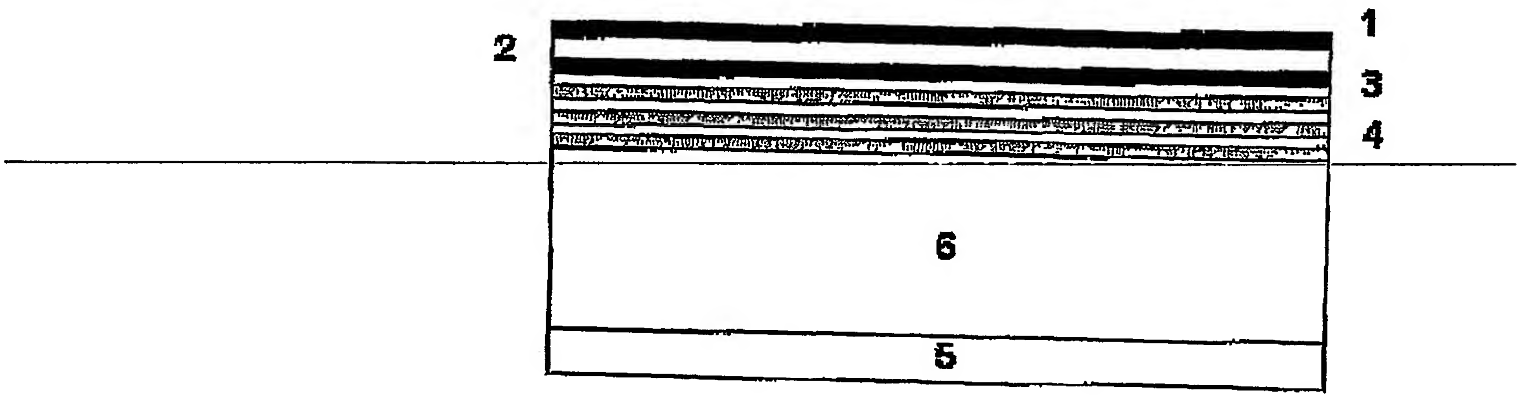

Fig. 2

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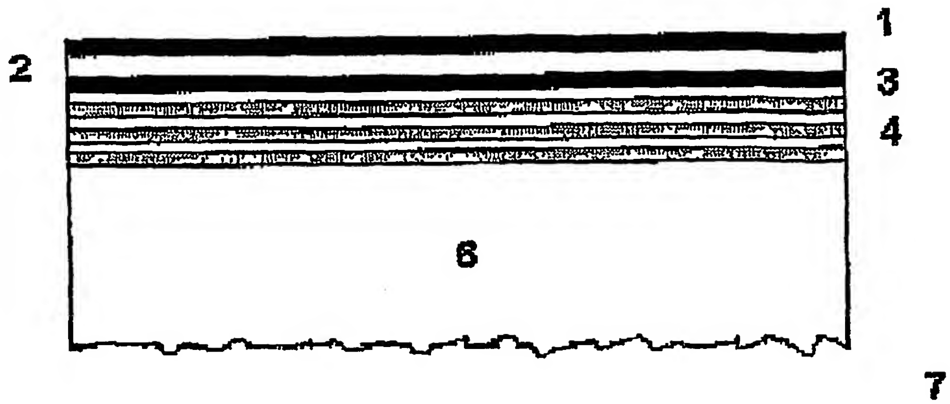

Fig. 3

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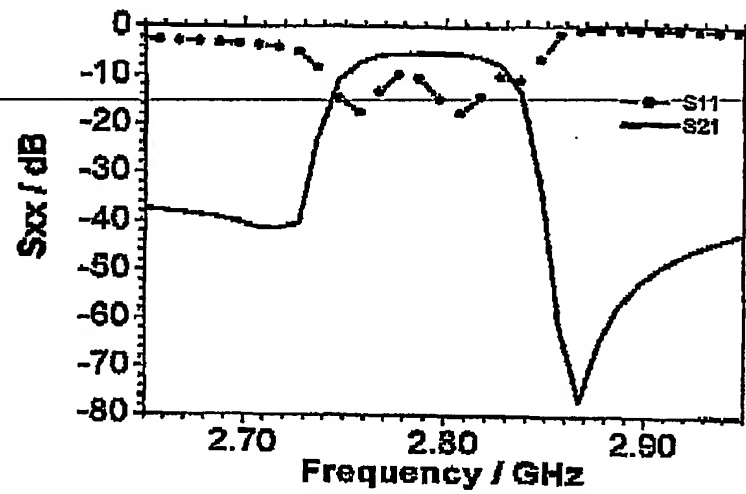

Fig. 4